From Design to Production

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All images are from the Canopy for the Wesend Gate Tower in Frankfurt, Germany, by Just. Burgeff, Architekten, and Asterios Agkathidis.

"Each time the architectural production technology changes, then Architecture changes as well," [1] argues Conrad Wachsmann, already in the late 1950´s. And it seems indeed to be a fact that big technological developments have always had an impact on architectural design and production.

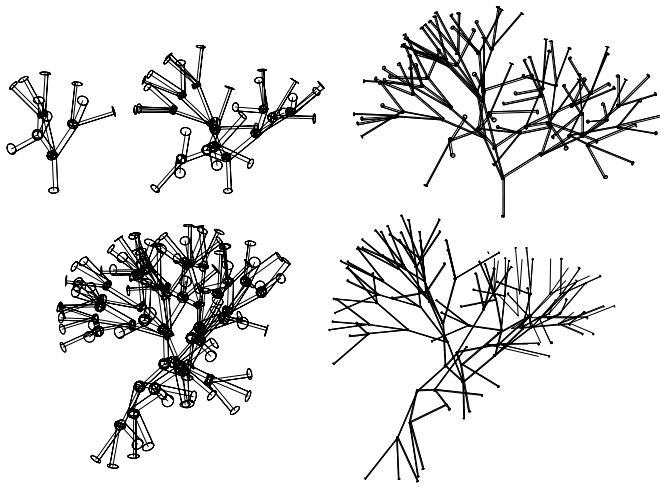
Built in the late 19th century, Paxton's Crystal Palace, inaugurated a new era, when mechanical production revolutionized design and structure, introducing completely new architectural aesthetics at the same time. The newly invented assembly line[2] industrial production seemed to make every architect's and developer's dreams come true: fast construction time at low cost and high efficiency.

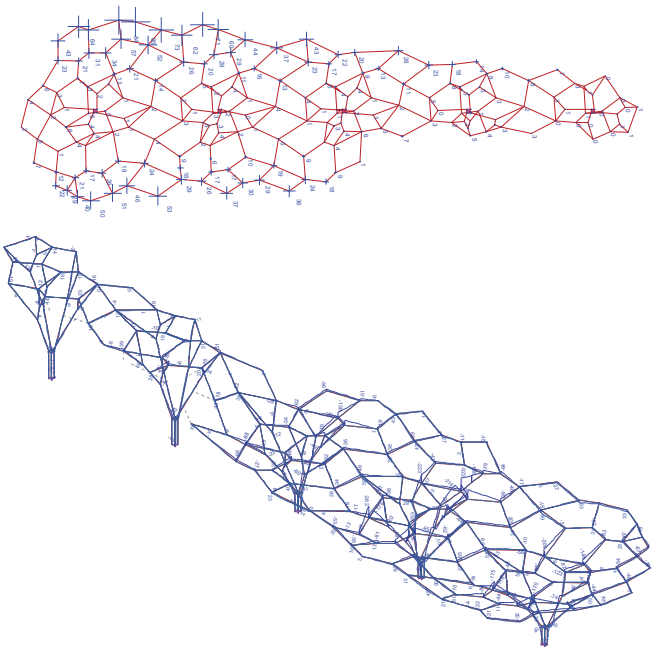
The urge to fulfill those three requirements motivated the Russian engineer Wladimir Grigorjewitsch Suchov to develop his hyper-parabolic mesh structures[3] in the same century. They consisted of mass-produced iron sticks, welded together in a minimal structure that combined fast construction requirements with an optimally efficient geometry. He thus introduced an almost perfect coherence between form, structure and production process. His intelligent structural system was used for the construction of at least 200 telecommunication towers throughout the Soviet Union. The use of the industrial manufacturing processes of his time played a fundamental role in conceiving and realizing the hyperbolic towers.

With further industrialization of architectural technology taking place in the beginning of the 20th century, serial mass production reached a greater degree of perfection. The notion of industrialization became a synonym for the notion of mass production. The fully automated factory can only operate efficiently if it can produce huge numbers of self-similar copies. The initial form-giving tool is the only original piece in such a process, thus also indirectly the final product. Wachsmann´s

"modular coordination"[4] describes an order, based on a system in which all components have a clearly defined relation to each other. It tries to define one universal unit categorized in geometries, tolerances, valuation and construction. This order was for him the only way to guarantee reliable construction quality. It also dictated a new relation between design and structure: "Industrial production cannot be abused as an excuse for realizing freely designed conceptions. It can only be used as a direct cause for the development provision of a product, which in a combination with the rest provides the finalized form", he argues.

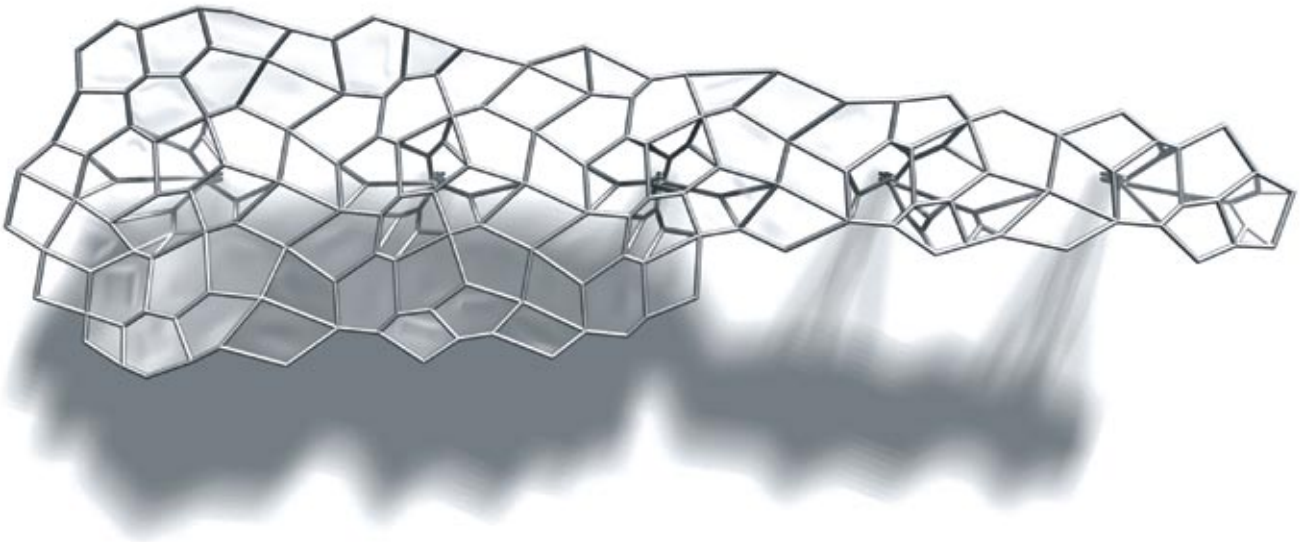
Today, emerging CAD/CAM design and manufacturing technologies allow a differentiated view of the previous dogma. The use of the computer seems to merge design and production into firmware. Mass fabrication and custom production are unifying into mass customization. The use of structural simulation techniques and algorithmic tools in an architectural process are decoupling the relation of cost to quality, efficiency and repetitive production processes. Furthermore, novel digital manufacturing techniques allow designers and architects to break previous boundaries of geometry and form.

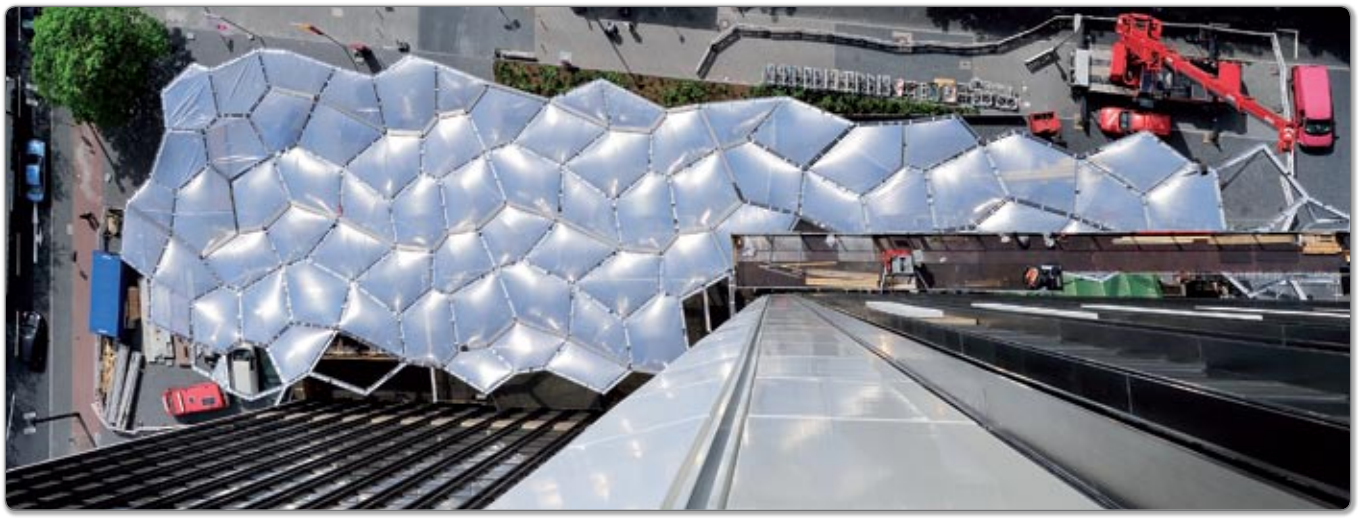


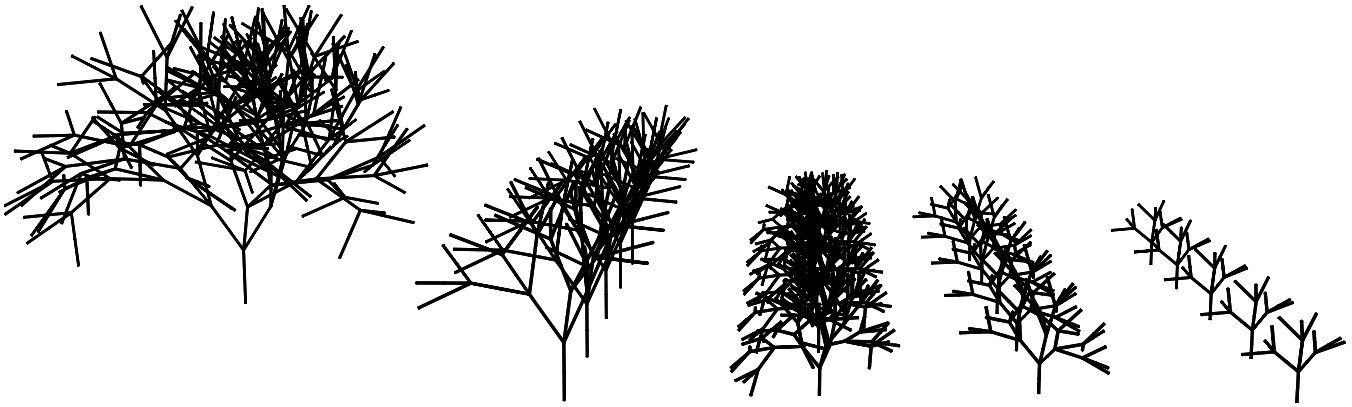


The canopy for the Westend Gate business centre in Frankfurt planned by Just/Burgeff Architeckten and Asterios Agkathidis is a good example utilizing the processes described above. It provides shelter to all the outdoor activities of the 160m high tower, just across from the main gate of the Frankfurt international fair. This includes the entrance area of the Marriott Hotel and its outdoor café/bistro as well as the entrance of the office facilities. The 12002 meter structure distinguishes itself clearly from the architecture of the tower. It almost merges with the typical plane tree lines of the Hamburger Alley, where it stands. It becomes an artificial piece of nature. The geometry of the canopy was developed from a voronoi pattern, generated by a tree-structure algorithm and further optimized through digital simulation. This bottom-up design process resulted in a double-curved tree mesh, put together by differentiated singular units. The roof is covered by pneumatic ETFE membrane cushions, a very light and flexible material, capable of adopting to double-curved surfaces. Thus the minimum possible steel consumption was achieved. For its manufacturing process, the latest CNC technologies were used.

Wachsmann's "modular coordination" is being replaced by the notion of performance, which includes coordination of more than one parameter into a system of equilibrium. The pre-digitalized production criteria seem outdated. In their place, individualized structures, as found in nature, are proving to achieve a greater degree of efficiency. With the further spread of CAM technologies and rising cost of resources, disadvantages found in such structures, such as high production cost and outlay, are fading away.







Moreover, the classical design procedure automatically transforms into a collaborative virtual system in which architects, engineers and manufacturers are linked together in a constantly updated flow of information. Typical architectural drawings, such as sections, elevations and floor plans are losing their importance, because they are unable to entirely describe complex geometrical structures. Meanwhile, the role of interactive digital models is gaining in importance. Various CAD files and application formats such as DWG, IGES or STL are becoming the only reliable data, carrying the responsibility for efficient transmission of design information. Thus, our understanding of precision and structural tolerance is being transformed, relating them directly to the equivalent requirements of each manufacturing machine.

These changes have a strong impact on classical construction. For instance, implementation planning is becoming more the responsibility of the manufacturer because of his ability to determine planning and production tolerances. The question of the legal responsibility of the architect arises: can an architectural practice be legally responsible for production drawings that are not realized through construction?

It's becoming clear that Conrad Wachsmann's theses about the relation of technology and architecture are more relevant than ever. We live in a time when digital manufacturing technologies are revolutionizing the architectural practice. The emerging transformation goes beyond morphological characteristics. It affects the essential procedures on which architectural production has been based for decades.

References

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Asterios Agkathidis (born 1974) studied architecture in the Aristotle Univ. of Thessaloniki, the RWTH (Aachen) and the Staedelschule (Frankfurt). He was a partner in the architectural practice b&k+ (Cologne, 2001- 04), and then worked for VMX architects (Amsterdam) until 2005. He founded the architecture and research laboratory *a3lab* Frankfurt - Thessaloniki, in the same year. Since then he has been practicing architecture and design publishing, exhibiting, winning prizes and realizing projects throughout Europe. Teaching and lecturing experiences include AdbK Nuremberg, TU Darmstadt, the Univ. of Thessaloniki, the Univ. of Bielefeld, the Columbia Univ. and the Staedelschule. He is currently visiting Professor in the LAU. In 2010 he published his 4th book, *Digital Manufacturing,* distributed internationally by BIS Publishers Amsterdam.